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EAST AFRICAN AGRICULTURAL RESEARCH STATION, AMANI

FIRST ANNUAL REPORT, 1928—29.

LONDON:
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.
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Adastral House, Kingsway, London, W.C.2; 120, George Street, Edinburgh;
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1930.

Colonial No. 50.

Price 6d. net.

58–50

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EAST AFRICAN AGRICULTURAL RESEARCH STATION, AMANI.

Report for the period 1st April, 1928, to 31st March, 1929.

INTRODUCTION.

The *Biologisch-Landwirtschaftlichen Institut* at Amani was established in 1902 by the Government of German East Africa. A summary of the work of the Institute to the end of March, 1914, may be found in the Annual Report for 1913–14 issued as *Beiheft zum Pflanzer, Jahrgang X., No.* 3, 1914. During the war the resources of the Institute were used to the fullest extent for the local manufacture of medical and other supplies no longer obtainable from abroad, and the available buildings were occupied as a refuge camp for German women.

The Institute was taken over by the British Forces in 1916 and the German staff was allowed to remain until after the Armistice, when its members were repatriated. Three remained until August, 1920.

An English Director, Mr. A. Leechman, took charge of the Institute in January, 1920, and it was later absorbed into the organization of the Department of Agriculture. No further appointments were made to the scientific staff, and, on Mr. Leechman's resignation in 1923, Amani was left in the sole custody of the head gardener, Mr. F. M. Rogers, until it was taken over by the present Director in March, 1927.

The area of the Station is some 750 acres, of which about a third remains under the original forest, while a large part of the remainder is occupied by permanent plantations of trees and shrubs collected from all parts of the tropics and each having some sort of economic interest. There is scarcely any land suitable for arable cultivation, and the Station, as taken over, would be most accurately described as a well-stocked arboretum.

The main buildings occupy the crown of a series of converging ridges at a height of 3,000 feet, and the plantations extend down the slopes to the Sigi River at 1,300 feet and ascend a neighbouring summit to a height of 3,700 feet. The region is one of heavy rainforest of the usual mixed tropical type. The average rainfall over 29 years is 77·03 inches with recorded extremes of 53·8 and 97·8 inches. The mean relative humidity is 84·4 per cent., the annual mean temperature 68·9° F., the mean daily maximum 76·3°F., and the minimum 61·5°F.

The present Director, on appointment, left British Guiana on the 16th November and reached London on the 7th December, 1926.

Instructions were received from the Secretary of State for the Colonies to proceed to Amani and, after taking over the Station and making a survey of its resources, to visit the six dependencies contributing to its support in order to obtain an acquaintance with agricultural conditions and to determine the lines on which research might most profitably be directed.

Amani was reached via Zanzibar and Dar-es-Salaam on the 2nd March, 1927. Considering the funds at the disposal of the Custodian, the Station generally was found to be in surprisingly good condition. The roads and plantations were in good order and the laboratories, library, and the botanical and entomological collections well-cared for. The Director's house was ready for occupation, but the interiors of most of the other dwellings were in a state of considerable dilapidation owing to the effects of damp and of termite infestation.

The first extended excursion made by the Director was to the districts of Moshi, Arusha, and Ngare Nairobi from the 26th March to the 8th April. Conferences were held with the Planters' Associations, and a considerable number of representative plantations both European and native were visited under the guidance of the Senior Agricultural Officer of the Northern District, Mr. R. W. Miller.

On the 25th April a visit was paid to Dar-es-Salaam for a conference with the Governor of Tanganyika Territory. Matters relating to the administration of the Station were discussed and the possibilities for its further development were greatly increased by the consent of the Governor to add to the Station the neighbouring Kwamkoro Coffee Estate, which had previously formed part of the Prince Albrecht plantations. The area of this estate is some 8,000 acres, of which approximately 1,000 acres had been cleared from heavy forest and planted with *Coffea arabica* densely shaded with *Grevillea robusta*. Kwamkoro provides what Amani so conspicuously lacks, considerable areas of gentle slopes and a certain amount of level ground with fairly good soil and capable of use for agricultural experimentation. There is a sufficiently equipped coffee factory and sawmill worked by water power.

From Dar-es-Salaam the journey was continued to Zanzibar and the period from the 3rd May to the 16th May was occupied in a survey of the agricultural industries of Zanzibar and Pemba in company with the Director of Agriculture, Mr. V. H. Kirkham. The work of Amani in relation to Zanzibar was fully discussed with the British Resident, Sir Claude Hollis, and other officers of the Zanzibar Government.

Northern Rhodesia was the next country to be visited, and Livingstone was reached by way of Beira, Salisbury, and Bulawayo on the 25th May. With the assistance of Mr. McEwen, Agricultural Research Officer, the western section of the country was traversed by rail and car to the border of the Belgian Congo at Sakania. Farms representative of the agricultural industries of the country

were visited and the site of the new experiment station at Mazabuka was inspected and the plans for its development discussed.

On the return journey to Beira it was necessary to remain three days in Salisbury, and the opportunity was taken of making the acquaintance of the officers of the Department of Agriculture and the Empire Cotton Growing Corporation, and of visiting the Government experiment station and tobacco farm.

From Beira, Nyasaland was reached by way of the Trans-Zambesi and Shire Highlands Railway on the 14th June. From Zomba as a centre fifteen days were spent in visits to tobacco, tea, coffee, and cotton districts. The Empire Cotton Growing Corporation Experiment Station at Makwapala was inspected. The commercial handling of the tobacco crop was followed from the field to the grading and packing sheds at Limbe. A meeting of the Agricultural and Commercial Society was attended at Blantyre. The excursions were arranged by the Director of Agriculture, Mr. E. J. Wortley, and for the most part were personally conducted by him and Messrs. Hornby and Smee of the Department staff. Full opportunity was afforded for the discussion of agricultural questions with officers of the Government, the Empire Cotton Growing Corporation, and the British Cotton Growing Association, with plantation owners, and with native cotton and tobacco growers.

The Nyasaland Government provided motor transport from Zomba northward along the west side of Lake Nyasa to Ekwandeni, and through the kind co-operation of Dr. Laws the journey was continued by monowheel to Karonga. The opportunity was taken of visiting farms along the route and of inspecting the interesting industrial developments at the Scottish Free Church Mission Station at Livingstonia. From Karonga the north-west corner of the Lake was crossed by sailing boat on the 11th July to Mwaya, where a motor lorry previously arranged for was in waiting for the journey across Tanganyika Territory to Amani. The route taken was by way of Tukuyu, Iringa, Kilosa, Turiana, Handeni, Korogwe, and Muhesa, and provided the opportunity of seeing a cross section of the agricultural development of the Territory. Amani was reached on the 17th July.

An attack of malaria prevented a projected visit to the Agricultural Show at Nairobi. On the 10th August the second section of the journey was begun, and Kisumu was reached by train from Muhesa *via* Moshi and Voi on the 14th August, and Entebbe by lake steamer on the following day. A stay of two days afforded opportunity of discussing with the Governor the proposed organization and policy of the Station and its relation to agricultural questions in Uganda. From Kampala, where the headquarters of the Department of Agriculture were inspected, and contact made with its officers, excursions were arranged by the Director of Agriculture, Mr. S. Simpson, to a representative rubber estate, to the Experiment Station at Bukolassa, to the

sugar plantation at Lugasi, and to the Cotton Experiment Station of the North-eastern Province at Serere. A day was spent at Jinja with the officer in charge of the grading of cotton.

On the return journey from Serere, the road was taken from Mbale eastward across the Kenya boundary to Eldoret, whence visits planned by the Director of Agriculture were made to places of interest illustrating the agricultural industries of the Trans-Nzoia. From Eldoret the journey was resumed by train to Nakuru where Mr. Anderson, Entomologist of the Department, was conducting a campaign against the stalk-borer of maize. A day was spent with him in visits to farms in the district.

Nairobi was reached on the 28th August. Contact was established with members of the headquarters staff of the Department of Agriculture, and the Acting Director, Mr. E. Harrison, provided much valuable information with regard to agricultural conditions in the Colony and arranged for as much of the surrounding districts to be seen as was possible in the time available. Visits were paid to the Scott Agricultural Laboratories and a day was spent with Mr. Kirkpatrick in an inspection of the Kiambu area illustrating his work on the problem of the infestation of coffee by mealy bug. An official conference took place with the Colonial Secretary and the Acting Director of Agriculture.

Further exploration of Kenya was prevented by the necessity of reaching England in time for the Imperial Agricultural Research Conference. Leaving Nairobi on the 2nd September and Mombasa on the following day, London was reached on the 23rd September.

The Director represented Amani at the above-mentioned Conference and took part in various committees and in the numerous excursions arranged to the principal centres of agricultural research in England and in Scotland. Meetings of the Colonial Agricultural Service Committee were attended at the Colonial Office, and numerous personal conferences on questions relating to the organization of the Station were held with officials of the Colonial Office and of the Empire Marketing Board. A draft scheme was put forward for the Station dealing with the composition of the staff, capital and maintenance expenditure, and the research programme proposed. This was eventually submitted to a special Advisory Committee consisting of Major W. E. Elliott, M.P. (Chairman), Sir James Currie, Sir John Farmer, Mr. J. F. N. Green, Sir David Prain, and Sir John Russell, with Mr. Brown, Imperial Institute, as Secretary. With minor emendations and certain reservations the scheme was recommended to the Secretary of State for approval.

Considerable time was given to enquiries with regard to suitable candidates for appointment to positions on the staff of the Station and recommendations were made which enabled the available posts to be filled in due course. Appointments had already been made of Mr. C. B. Williams as Entomologist and Mr. G. F. Clay as

Geneticist, and from the time of his arrival at Amani in June, 1927, the former had charge of the Station during the Director's absence.

With the assistance of the Crown Agents for the Colonies a large amount of equipment was purchased for shipment to Amani. This included a hydro-electric plant to be installed on the Sigi River, a Mansfield gas plant, an insect-proof greenhouse, and a Thornycroft six-wheel lorry. Thanks are due to the Director of the Imperial Institute for the provision of office accommodation which greatly facilitated the transaction of business during the Director's stay in London, and for the opportunity of attending meetings of the Advisory Committees on Empire Produce connected with the Institute.

Before returning to East Africa the Director paid a short visit to Berlin and had the pleasure of meeting Professor Zimmermann in whose charge the Amani Institute was developed, and Dr. Eichinger, a previous member of the staff. He left Marseilles on the 10th February and acting on instructions received during the voyage proceeded direct to Zanzibar for the purpose of giving evidence before the Closer Union Commission under the chairmanship of Sir E. Hilton Young. The members of the Commission had previously paid a brief visit to Amani.

The Director reached Amani and resumed charge of the station on the 11th March.

STAFF LIST.

		Assumed duty.
Director	W. Nowell, C.B.E., D.I.C., F.L.S.	24th February, 1927
Entomologist	C. B. Williams, M.A., F.E.S.	28th June, 1927
Plant Pathologist ...	H. H. Storey, M.A., Ph.D. ...	6th March, 1928
Soil Chemist	G. Milne, M.Sc., F.I.C. ...	2nd September, 1928
Biochemist...	R. R. Le G. Worsley, A.R.C.S., B.Sc., Ph.D.	19th April, 1928
Plant Geneticist	G. F. Clay, M.C., B.Sc., N.D.A., N.D.D. (Hons.).	10th August, 1927*
Plant Physiologist ...	F. J. Nutman, A.R.C.S., M.Sc., D.I.C.	14th September, 1928
Superintendent of Plantations.	F. M. Rogers	3rd December, 1920
Secretary and Librarian ...	R. E. Moreau	20th March, 1928
Botanist	P. J. Greenway	28th April, 1928
Assistant Superintendent of Plantations.	K. E. Toms	5th January, 1928
Manager, Kwamkoro Coffee Estate.	E. M. Nicholl	1st January, 1928
Engineer-Mechanic ...	J. I. Bradshaw	25th June, 1928
Engineer (Temporary) ...	T. V. Greenwood	1st October, 1928
tenographer	(Miss) K. Rushworth ...	6th March, 1928.

* Transferred to Uganda 28th November, 1928.

RECONSTRUCTION AND ADDITIONS.

The buildings taken over at Amani have walls of local stone which are for the most part quite sound. The woodwork, on the other hand, especially in the dwelling houses, had become seriously infested with termites and has needed extensive replacement. The following statements show the number and nature of the principal buildings as they now stand, and summarize the work that has been done on them in addition to the general repairs required by all the previously existing buildings. Except where otherwise stated, the constructional work entailed has been carried out by the Station's own workmen under the supervision of the Superintendent of Plantations.

Laboratories and Offices.

Library.—The zoological laboratory which shared the library building has been transferred and its place is now occupied by a reading and reference room. A map room, librarian's office, and an extension of the book-binding workshop are under construction.

Zoology Laboratory.—A separate building for zoology has been provided by constructing a new laboratory 29 by 20 feet adjoining the rooms formerly in use as the Entomologist's quarters.

Botanical Laboratories.—The building has undergone no change. Two large rooms are occupied by the Systematic Botanist and the

Plant Physiologist. Of the four smaller rooms, two are in use for photographic purposes, and two are available as personal laboratories.

Pathological Laboratory and Office of Geneticist.—Adequate accommodation for these has been provided by internal re-arrangement of the building previously used as the General Office and Secretary's Quarters.

Chemical Laboratory.—This has been adapted without material change of the previous arrangement.

Soil Laboratory.—A new building has been erected, partly by contract, consisting of three main rooms joined to previously existing store rooms.

General Office.—The building used in German days as a hotel has been extensively repaired and re-arranged to provide :—

(1) Two rooms for general office purposes ;
(2) Accommodation for the post and telegraph office and telephone exchange ;
(3) Two rooms with kitchen and bathroom for the use of visitors.

Workshops.—The workshops have been re-arranged and extended. Adequate equipment is provided for wood-working and general mechanical fitting and repairs. A building previously used as a store has been reconstructed to provide the Engineer's Office and store and the Staff Workshop.

Scientific Store.—Accommodation is provided for general scientific stores in the building previously used as a Post Office.

Laboratory and Domestic Furniture.—The benches and furniture required for the equipment of the laboratories and offices have been made at Amani, for the most part with wood from the local forest, prepared in the Kwamkoro Estate saw-mill. A large quantity of the domestic furniture required has also been locally made. Early attempts to bring this in from Tanga and Mombasa were discontinued owing to the damage entailed in transport. The provision of new furniture to date includes :—125 chairs of various kinds, 10 settees, 5 dining tables, 4 sideboards, 18 writing desks and tables, 22 dressing tables and washstands, 9 chests of drawers, 11 wardrobes, 10 bookcases, and 8 dinner wagons.

Superintendent's Office.—A two-roomed building near the Nurseries has been adapted to serve as the Superintendent's Office, and a building in the same neighbourhood as a Plantation and Nursery Store.

Cowsheds and Manure Pen.—The cowsheds have been reconstructed on more modern lines and calf pens added. Covered concrete pits have been constructed for the conservation of farmyard manure.

Greenhouse.—An insect-proof greenhouse, made by Messrs. Mackenzie and Moncur, Ltd., Edinburgh, to the specifications of

Dr. Storey, has been erected for use primarily in research on virus diseases.

Water Supply.—The station is supplied with water by gravity through a pipe line 2,200 yards long from a stream in the forest remote from any source of human pollution. Owing to corrosion and fouling of the pipes, the supply had become inadequate and a new two-inch pipe line has been laid down.

Gas Supply.—Gas was previously supplied to the laboratories from a small petrol gas machine which was found to be no longer serviceable. Its place will be taken by a Mansfield Gas Plant with a holder of 2,000 cubic feet capacity now in course of erection. Delay has been caused owing to the difficulty of transporting the heavy castings and to the necessity of replacing parts which arrived at Muhesa broken.

Electricity Supply.—Slow but continued progress is being made towards the installation of a hydro-electric plant on the Sigi River at a distance of about one mile from Amani. The fall obtained is 124 feet and the minimum flow of water is more than adequate. The 15-inch pipe line is 450 feet long, and the generating unit consists of a Pelton type turbine coupled to a 20 Kilowatt, 1,000 volt, 3-phase alternator. The pipe line is large enough for the addition of a second generator of the same size.

Telephones.—A local system of telephones has been installed by the Tanganyika Post Office and is connected through Muhesa with the telephone system of the Territory.

STAFF QUARTERS.

House.	*Occupied by.*	*Rooms.*	*Work Carried Out.*
1	Director	8	Director's office and kitchen extension built on. New staircase and extra bathroom.
2	Engineer	2	Bathroom added.
3	Entomologist ...	5	Internally reconstructed.
4	Unoccupied ...	4	New. Built by contract.
5	Biochemist ...	4	Internally reconstructed. Rain-water cistern provided. New road made.
6	Secretary	4	New. Built by contract.
7	Superintendent ...	4	Dining-room enlarged. Verandah added. Woodwork renewed.
8	Assistant Superintendent.	3	Third room added and internally re-arranged. Kitchen, bathroom, and storeroom built.
9	Systematic Botanist.	3	Verandah, bathroom, storeroom, and kitchen added. Roof renewed.
10	Plant Pathologist Soil Chemist ...	6	Floors renewed.
11	Plant Physiologist	4	New. Built by contract.
12	Unoccupied ...	2	Not yet repaired.
13	(Sigi) Unoccupied	2	Not yet repaired.
14	(Kwamkoro) Manager.	6	Rain-water cistern provided.

Roads.

The Kwamkoro Estate as taken over was connected to Amani by a bridle path only and in the past the crop was carried to the railway by porters over a steep mountain footpath. A motor road from Amani has now been constructed through the exceedingly heavy forest which lies between. It is close on four miles in length with three bridges, and its construction necessitated the cutting or digging out of many hundreds of trees of which a considerable proportion were of great size. On Kwamkoro Estate the existing roads connecting the various coffee plantations have with relatively little trouble been widened to take motor transport, the material for the necessary bridges being provided by the all-too-abundant Grevilleas. Without the twenty odd miles of track thus provided the supervision of the Estate by a single European, as at present carried out, would be impossible. The harvest is also greatly facilitated. The five-mile section of the main road between Sigi and Amani, remembered by all visitors for its succession of hairpin bends, has been widened to a minimum of 15 feet and a thorough drainage system provided, involving the construction of more than sixty culverts. These have been constructed of masonry and covered with concrete slabs. In addition to this local road work the Station has, up to the present, accepted charge from the Public Works Department of the remaining portion (20 miles) of the road to Muhesa.

Transport.

The difficulties of transport have been a heavy and constant brake on the progress of the work of reconstruction. Between five and six hundred tons of materials of all kinds, including heavy machinery, have been transported during the year over twenty-five miles of road which has been officially described as a mere mountain track. It may be added that the road has perforce been considerably improved during the process, but it is still difficult in wet weather The re-opening of the narrow gauge railway from the main line at Tengeni to the boundary of the Research Station at Sigi, which is expected to take place at the end of June, will provide, in combination with the reconstruction of the section of road referred to above, a means of transport and of access available in all weathers and with the element of adventure at present associated with the journey largely removed.

Kwamkoro Factory.

The coffee factory at Kwamkoro is equipped with a large double pulper run from a water wheel, and is furnished with a drying shed in which hot air is impelled by a fan through a floor of perforated metal. Both buildings and machinery have required extensive renovation and are now capable of dealing satisfactorily with the crop. The factory also includes a saw-mill, which has proved exceedingly useful. Without it the difficulty and expense of restoration would have been enormously increased.

Labourers' Quarters.

The labourers' quarters at Kwamkoro have been entirely reconstructed and a beginning has been made with the rebuilding and re-arrangement of the native village at Amani.

RESEARCH PROGRAMME.

I.—Surveys.

1. The study of the basic types of East African soils; their characteristics, formation, distribution and variation in relation to climatic and other influences.

This work to be contributory to, and correlated with, the projected African soil survey.

2. The collection and correlation of data regarding climate.

(A central organization for the study of the climate of East Africa has now been established, with headquarters at Nairobi.)

3. Study of the results of the interaction of soil and climate as expressed in the natural vegetation (with its associated fauna) involving—

(*a*) the recognition and description of characteristic plant associations,

(*b*) the study of their relation to the conditions which determine their existence,

(*c*) their value as indications of agricultural possibilities, and

(*d*) the mapping, as opportunity affords, of their distribution.

(The ideal is a description of East Africa in which the inter-relations between geological structure, soil, climate, vegetation, animals, and man and his industries would be worked out. It can only be done in broad outline at present, with patches of detail, but will afford useful information at every stage of its construction.)

II.—Investigations.

(1) *Coffee problems.*—Coffee production in many parts of East Africa cannot be said to have passed out of the experimental stage. Success with the first plantings on virgin soil does not by any means ensure permanence of production. (Nyasaland had a coffee industry which died out completely). In some circumstances even the first planted trees suffer severely from overbearing, i.e. dieback, consequent on what is regarded as prematurely heavy crop production. Under certain conditions of exposure, again, an abnormal bunchy type of growth is induced, with suppression of bearing.

The provision of shade, which in a wide sense may be taken to include soil covers, temporary and permanent overhead shade, and wind-breaks, affords the readiest means of adjusting conditions, but in regard to its use there is the utmost confusion. Much coffee is grown like an arable crop, fully exposed and constantly cultivated, while at the other extreme are fields in which the coffee bushes are almost suppressed in a dense plantation of trees. Commonly this difference in practice has little or no relation to local conditions.

No general rule regarding shade can ever apply, but the subject requires fundamental study with reference to the influence of shade on vegetative development, on crop production, and on the conservation of soil fertility. Such an enquiry will be both complex and prolonged, and will make demands upon the services of each member of an all-round staff, since every branch of agricultural science will be involved.

(2) *Problems connected with the conservation or restoration of soil fertility*—

(*a*) The changes induced by continuous arable cropping without manure.

(*b*) The effects of weed or bush fallow as practised by native agriculturists, including the effects of burning the bush.

(*c*) How far these effects can be economically improved upon by controlled planting, either of recognised green manure or other plants.

(*d*) The effects of clean cultivation with permanent crops (coffee, tea, rubber).

(*e*) The study of the liability of certain soils to heavy loss by washing.

(*f*) The study of possible crop rotations.

(3) *Plant breeding*—

(*a*) *Coconuts*—In the average plantation a large proportion of the crop comes from a relatively small proportion of the trees. This appears to proceed from a fixed capacity to produce female flowers, in numbers which vary from tree to tree from one or two to fifty and more per inflorescence. The inheritance of these characters needs investigation with a view to establishing heavy bearing races. The relation between nutrition and the shedding of young fruits needs examination. (In cotton, liability to shedding is an inherited character.)

(*b*) *Cinchona*.—The plantations already established at Amani afford material for selection and hybridization with a view to high percentage production of quinine and the possible establishment of the industry in East Africa.

(*c*) *General*.—Breeding and selection work on such crops as tea, coffee, cotton, and sugar-cane should be carried out with a purpose going beyond that of similar work in agricultural departments, i.e., not only directly to secure higher production, better adaptation, or superior quality, but to investigate the basis on which these characters are founded and the methods of their inheritance.

(4) *Insecticides*.—It is proposed to collect and grow a wide range of plants used as fish poisons, etc., for the study of the production and use of their active principles as insecticides, in continuation of, and, it is hoped, in co-operation with, work on this subject at Rothamsted.

(5) *Insect Migration.*—The Entomologist will continue his study of this little-known but important subject.

(6) *Virus Diseases.*—The Plant Pathologist will continue the investigation of virus diseases of tropical plants.

(7) *Pests and Diseases.*—The problems presented by specific pests and diseases are too numerous to mention in detail. There is ample scope for fundamental investigation which will not interfere with the functions of departmental officers. For example, the investigations on shade and no-shade will include effects on the incidence of injurious insects and fungi, and there are other influences which result in pests which are serious in one country being comparatively harmless in another.

IIIa.—Correlation Services (Internal).

(*a*) Comparison of crop plant varieties in the East African territories with reference to their adaptation and distribution.

(*b*) Recording the distribution of plant pests and diseases and of the agencies of natural control.

The information thus collected will be directly available to the officers of agricultural departments, who at present have no ready means of obtaining it.

IIIb.—Correlation Services (External).

(*a*) Introduction of new plants or new varieties. There is a reduction of both expense and risk in carrying out as much as possible of this work at one centre, and it should be done where reference to experts is possible in regard to inspection and quarantine.

(*b*) The co-ordination of measures to exclude pests and diseases. This should be accomplished by conference, and contact maintained through the Central Station.

The Advisory Committee has recommended (Minutes of Meeting held 19th December, 1927) that the adoption of this programme should not preclude the Director from undertaking other investigations as and when required, and that the utmost latitude should be allowed to the Director to follow up promising developments even though their economic importance may not be immediately apparent.

PROGRESS REPORT.

It will be gathered from the account already given that the provision of buildings and equipment for the different sections has occupied the whole of the year under review and is not yet completed. Facilities for systematized work have not existed, but progress has been made in numerous directions with the investigations outlined in the research programme and the members of the staff have been afforded opportunities for laying the foundations of a knowledge of East African conditions. Under these circumstances sectional reports have not been called for, but the following summaries indicate the nature of the work which has been undertaken.

Entomology.

The Entomologist has completed during the year a monograph on the migrations of butterflies and moths, which is expected shortly to be published. This represents the results of a study of the subject extended over many years, and it happens that East Africa in general and Amani in particular have supplied a large amount of new material. While the subject has little direct agricultural interest, its study contributes to the knowledge of insect migration in general, the importance of which has been sufficiently demonstrated by the locust invasions of the present year.

At the request of the Kenya Department of Agriculture, Mr. Williams visited Kenya from the 25th July until the 18th August and again from the 21st November until the 15th December to observe the first phases of the locust infestation. Subsequently the passage of numerous swarms through Amani and the surrounding districts afforded more than ample opportunity for further observations. The large variety of native and exotic plants existing on the Station effectively demonstrated the preferences of the insect with regard to food plants, and the information obtained will be published later.

Plant Pathology.

The attention of the Plant Pathologist has been principally given to the study of virus diseases. Five of these affecting important crop plants are available for investigation at Amani, i.e., the mosaic disease of sugar-cane, the streak disease of maize and other Gramineae, the rosette disease of ground-nut, the curly-leaf disease of cassava, and the mosaic disease of tobacco. The insect vector of streak, *Cicaduline mbila*, originally determined in South Africa, has now been found by Dr. Storey in Tanganyika, Kenya, and Uganda. Supplies of the insects have been bred for future work. The results of the several lines of investigation in hand will be published in due course.

A severe affection of tobacco believed to be non-parasitic in origin, in which the leaves are exceedingly crumpled and deformed, occurred simultaneously at Amani and in plots grown by the Department of Agriculture in Zanzibar. It has been taken under investigation with a view to the determination of its nature and the mode of its transmission. A sisal disease, also non-parasitic, which gave rise to some temporary alarm during the year by the suddenness of its occurrence, has been taken under observation. A bark disease of coffee from the Western Usambara is under investigation.

During September, October, and November, the Plant Pathologist, in company with the Soil Chemist, made an extensive tour of Kenya and Uganda for the purpose of making acquaintance with agricultural conditions and problems and of making contact with the officers of the Departments of Agriculture. Journeys have also been made to Pangani and to the Western Usambara. Arrangements are under discussion for a visit to Nyasaland.

Soil Science.

Shortly after his arrival the Soil Chemist took part in the above-mentioned journey to Kenya and Uganda, and the major part of his subsequent work has consisted in the examination of the soil samples then collected along with others obtained in Tanganyika Territory. The samples have usually represented complete profiles of the soils in question, and, upon the basis of field observations and limited laboratory data, some eight or ten different kinds of soil-profile have been recognized, each with variations within its type. Close definition of these groups, and their place within recognized schemes of classification, must depend upon later chemical and physical investigation of selected material and the acquirement of an extended range of samples and of field knowledge.

Plant Breeding, Plant Introduction and Distribution.

In the Station as taken over, the collections of economic plants of short duration, as distinguished from shrubs and trees, had been almost entirely lost. By means of purchase and exchange good progress has been made during the year towards their restoration. To meet an obvious need of the country special attention is being given to the collection and trial of plants suitable for use as cover crops and green manure. The collection and comparison of trees for use as permanent shade under various conditions has received close attention, including systematic observations of their changes of foliage during the course of the seasons. With a view to the selection and improvement of the permanent crop-plants, as many different types and varieties as possible of coffee, tea, and citrus have been obtained and brought under cultivation, and selections have been made from local material of robusta and arabica coffees. Some attention has been given to the selection of Cinchona on a basis of total alkaloids ; the possibility of closer discrimination awaits the completion of the bio-chemical equipment. A beginning has been made in a study which may have important results by the raising of a large number of sisal plants from seed kindly supplied through the East African Sisal Growers' Association.

To meet a request of the Tanganyika Government the Geneticist, in company with the Botanist, made a trip to Kondoa Irangi and Dodoma from 6th–30th August, for preliminary observations on the problem of improving grazing and browsing conditions in the semi-arid pastoral districts. Inter-departmental co-operation on this important subject is now being arranged. Accompanied by the Plant Physiologist, the Geneticist visited Moshi and Arusha on 10th–20th November for observations on coffee shade, and to discuss with planters arrangements for the comparative trials of permanent shade trees.

Mr. G. F. Clay relinquished the post of Geneticist on the 28th November. No appointment has yet been made of a successor, but many of the duties of the post have been carried out by Mr. L. R. Doughty, Colonial Agricultural Scholar, who arrived on the 17th November.

A beginning has been made with the accumulation of data for the analysis of coffee yield as a necessary preliminary to selection and the evaluation of methods of treatment. The irregularity of the trees makes observation difficult and new plots have been established which in due time will afford better material. Statistical work on the distribution of flowers and fruit has been seriously interfered with by locusts.

At the request of the Committee of the Paint Research Association, and with the co-operation of the Directors of Kew and the Imperial Institute, a series of widely scattered trials has been arranged of the trees yielding Tung Oil, *Aleurites fordii* and *A. montana*. Plants to the number of 4,800 were raised in the Amani nurseries from seed supplied by the Paint Research Association and distributed in Tanganyika, Kenya, and Zanzibar. Small plantations at various levels were established locally for observation. From a later consignment, arranged for by Kew, seed was sent to Uganda, Nyasaland, and Northern Rhodesia.

In continuation of previous practice, seed of coffee, especially robusta, and of a large variety of useful trees was supplied during the year to Agricultural Departments and to the general public. The revenue from this source amounted to £178.

Biochemistry.

Organized work in this section will only be possible when the process of renewal of stock and equipment is completed by the provision of gas and electric current. In addition to the work of re-arrangement, the Biochemist has occupied himself with the following matters—preliminary examination of the so-called black cotton soil ; the baling of clove leaves for distillation ; determination of the alkaloid content of Cinchona spp. and varieties, preparation of Cinchona febrifuge ; and the study of methods for the extraction of Sanseviera fibre. A good deal of this officer's spare time has been given to the re-organization of the library.

Systematic Botany.

The considerable collections in the herbarium have been thoroughly overhauled. Progress has been made with a survey of the Amani plantations for the purpose of putting on record the results of the very large number of introductions made since the establishment of the Institute. As recorded above, the Botanist took part in preliminary observations connected with the improvement of pasture, and as part of the same investigation has undertaken the identification of collections which continue to be made by the Veterinary Research Officer. Also in this connection plants which may prove to be of value for grazing or fodder are being obtained and distributed for trial in appropriate districts.

In response to a request from the Government of Zanzibar, Mr. Greenway visited that dependency from 19th January–27th February for the purpose of advising on the organization of a survey

of the flora which is to be undertaken by the Zanzibar Museum. The Station will co-operate with the Kew Herbarium in the identification of the material collected.

Plant Physiology.

The recognition of the need for the direct co-operation of the plant physiologist in the general scheme of agricultural research is a comparatively recent development and the methods of application of this science have, in many directions, still to be worked out. Much special equipment is required and has to be adapted to, or developed for, the particular purpose in view. The main problems on which it is proposed to work at Amani are those connected with the use of shade in coffee cultivation. The officer responsible for this section has been occupied with assembling the equipment of his laboratory, the whole of which is entirely new, and in preliminary investigation of the methods to be adopted.

Library.

There exists at Amani the nucleus of a good general collection of scientific books and periodicals and its development will supply the obvious need of a central reference library for the workers in the many lines of biological research now being pursued in East Africa. It is hoped that this possibility of a usefulness beyond the service of the Station itself will lead to the special provision of funds for its development.

Much work has been done during the year in the revision and re-arrangement of the collection and much remains to be done. The number of books added during the year, apart from periodicals, is 224.

The book-binding workshop has had new equipment added and is a great convenience. The work of the native book-binders employed reaches a good standard.

Plantations.

Amani.—Allusion has already been made to the trial plots established of *Aleurites* (for Tung Oil) and coffee and citrus varieties. Recently established plots also exist of *Hydnocarpus wightiana* (for Chaulmoogra Oil) and *Musa textilis* (manila hemp).

The greater part of the Amani slopes is occupied by long established plantations of trees which have required no attention beyond in some cases an occasional weeding. Considerable space can be made available as required by the cutting out of useless rubber trees. In the nursery plots, in addition to the cover crop and green manure plants already mentioned, trials are being made of plants yielding insecticides, (*Tephrosia*, *Derris*, *Chrysanthemum*), and essential oils, and also of a number of introduced grasses and other fodder plants.

Kwamkoro.—The coffee cultivation at Kwamkoro is estimated to cover about 900 acres made up of numerous plantations more or less

widely separated by original forest. The closely planted Grevillea shade had been allowed to develop unchecked, and when the estate was taken over many areas were almost indistinguishable in general appearance from the forest itself. The coffee trees have now all been cleared from the heavy growth which surrounded or covered them, most of the areas being clean weeded in order to permit of the reduction of the great inequalities of surface due to previous methods of cultivation. The weeds as far as possible were buried in the process. The policy has been adopted of using the bush knife and not the hoe for subsequent weed control. Progress has been made in the removal or reduction of the Grevillea shade, but the work entailed is laborious and difficult and will take years to complete.

The condition of the coffee trees, over very considerable areas, is highly satisfactory in regard to their size and vigour, but the form of the trees and their distribution are too irregular for them to have much value for experimental purposes. Areas suitable in their soil and contour, of which several exist, will for these purposes need to be renewed either by complete cutting back or by replanting. Trials to determine the response to these measures have been instituted. It is planned to lay out plots for comparison of the effects of different degrees and qualities of shade and of different systems of cultivation and manuring, and of the behaviour and yield of different varieties. Variety plots of "Kent's" and "Jackson's," of which sufficient nurseries are already available, are being planted during 1929. Some 20 acres of valley land have been cleared from secondary bush and planted with cassava, maize, rice, bananas, and other local food crops.

The coffee crop of 1928 on all the estates in the Amani district failed almost completely. The yield at Kwamkoro fell short of ten tons. An estate not far away, for which figures of past returns are available, made only one-twentieth of its normal crop. There was no obvious reason for the failure. The latter half of 1927 was excessively wet which may have had the effect of stimulating vegetative growth to the exclusion of reproductive activity. A spectacular production of flowers all over the Kwamkoro plantations in March, 1929, gave promise of a record crop to compensate for the previous year's failure. This prospect was seriously reduced by the unlucky arrival of clouds of locusts on the day that flowering reached its peak, with the result that in two or three hours there was scarcely a petal to be seen. Recovery has taken place in some plantations through renewed flowering, in others this has not occurred to any satisfactory extent. Appearances are that the crop will be about half of what might have been expected. The revenue should still be sufficient to meet the expenses of the estate, including work which should greatly increase its future yield, so that at worst the opportunities afforded for observation and experiment will have been gained without charge on the externally provided income of the Station.

Native Labour.

The scarcity of native labour has been a constant source of anxiety throughout the year. It has been more responsible than even the difficulties of transport for the length of time that has been taken for the reconstruction of the Station. The population in the vicinity is scanty and the climate of Amani is exceedingly unpopular with the inhabitants of the lower levels. The importation of men of the hardier tribes of Central Tanganyika is a necessity, but is difficult to arrange without the services of the professional recruiter, and is in any case expensive. It is hoped that improvement in the arrangements for food supply and efforts to provide congenial living conditions will lead to the increase of the resident native population.

Health.

The health of Europeans has been generally good. Some mild cases of malaria, apparently contracted on the Station, and mainly affecting women and children, have occurred. A mild epidemic of bacillary dysentery had a similar incidence. Although a great deal of dangerous work has been carried out during the year, there have been no serious accidents except for the one case of a workman in the Kwamkoro Factory who was fatally injured through taking an unauthorized short cut over the main shaft.

Thanks are due to the Universities Mission for the services of their medical staff stationed at Tongwe, which have been frequently called upon and promptly rendered in cases of emergency affecting both Europeans and natives.

Low-Level Station.

It is physically impossible to have in East Africa an agricultural experiment station representative of more than a narrow range of the conditions existing from the coast to the interior highlands. It will be necessary to arrange in one way or another for secondary stations as trial-grounds in connection with Amani. The re-opening of the Sigi Railway which is expected to take place in June, 1929, will make it possible to resume the occupation of an area of some 80 acres near Tengeni belonging to the Station. This is arable land, with a typical red loam soil, believed to possess an average degree of fertility. It represents an approach to lowland conditions but is within the influence of the Usambara mountains and has accordingly a rainfall higher than is characteristic of the coastal plain generally. Proposals are under consideration for the acquisition of a low-level station on the open plain towards Tanga. The establishment of a sub-station somewhere in the Moshi-Arusha area is also much to be desired.

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